

LA-UR-14-27639

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Title: Uranium Oxide Solar Cell

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Intended for: I will send the slide to a colleague at the Naval Surface Warfare
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Issued: 2014-09-30

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Uranium Oxide Solar Cell

From nuclear waste to renewable energy: thin-film solar cells from depleted uranium oxide

BACKGROUND & MOTIVATION

- Depleted uranium oxide (DUO), is an abundant and cheap waste product of nuclear fuel enrichment process
- Its supply will grow with the expected growth of the nuclear energy industry
- Solutions for reduction of the stockpile are needed
- DUO films have properties appealing for use in solar cells (e.g., band-gap tunability, low cost, abundance)

INNOVATION

We propose to develop a proof-of-concept uranium oxide solar cell.

- We have developed methods for rapid and cheap deposition of DUO as a thin film on various substrates
- Optical and electronic properties of the film can be tuned by variations in the deposition conditions
- This process will be used to form p-n junctions and fabricate proof-of-concept PV devices. DUO p-n junctions have not yet been demonstrated
- Thin uranium oxide film fabrication capability can be readily included to a standard nuclear fuel fabrication process.

DESCRIPTION

DUO Films Production:

- The uranium oxide films will be fabricated at the Target Fabrication Facility using standard physical vapor deposition (PVD) technique [I.O. Usov et al., J. Nucl. Mater. 437 (2013) 1]
- Undoped uranium oxide has p-type conductivity. To achieve n-type conductivity we will dope it with elements from the III-group of the Periodic Table (Al and B) substituting for oxygen.



Colors of DUO films controlled by deposition conditions

Films Characterization and device fabrication:

- Understanding of optical properties of uranium oxide is limited [Meek et al., Mater. Letts 59 (2005) 1085; Schoenes, J. Appl. Phys. 49 (1978) 1463]; with band gap estimated to be in the range 1.5 – 2.5 eV – optimal for use in PV.
- The band gap likely depends on, and can be controlled by the oxygen content, resulting in different oxide phases (UO_2 , U_3O_7 , U_3O_8 , UO_3).
- Optical characterization of various oxide films, PV device fabrication and characterization will be done at Dr. Sykora's laboratories using approaches developed previously [e.g., M. Sykora et al., ACS Nano. 2010, 4,6377.]

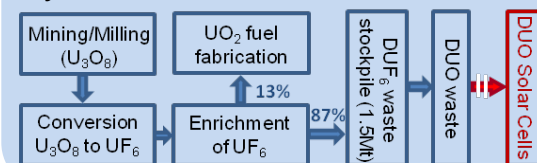
Current Technology Readiness Level (TRL) 3

We have a great deal of experience in uranium oxide films growth and PV devices fabrication.

ANTICIPATED IMPACT

Possible path to reduction of nuclear waste stockpile with the renewable energy and optoelectronics benefit.

- Immediate potential sponsors include DOE, DOD, and nuclear energy industry, who are searching for civilian solutions for reduction of depleted uranium stockpile.
- Excellent radiation tolerance of uranium oxide to bombardment with energetic particles, makes it also attractive for space solar panel applications.
- Successful demonstration of p-n junction device will be of interest to PV community and also open an opportunity to make other radiation-hard electronic devices.
- Our vision of Solar-Nuclear Fuel Cycle:



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